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165. Proposed by O. W. ANTHONY, DeWitt Clinton High School, New York City.

Find the approximate form of a tower of circular cross section 1000 feet high and having a radius of lower base 20 feet, and so constructed that all the parts of the structure shall be subject to the same stress, due to the weight of the part of the tower above.

I. Solution by G. W. GREENWOOD, B. A. (Oxon), Professor of Mathematics and Astronomy in McKendree College, Lebanon, Ill.

Denote the radius of the section by r, and the height by h. The decrease in area of the sections parallel to the base is proportional to the decrease in the weight.

$\therefore -rdr=kr^2dh$. $\therefore \log(20/r)=kh$, since $r=20$ when $h=0$.

If the radius at the top be a, $\log(20/a)=1000k$.

$\therefore 1000\log(20/r)=h\log(20/a)$.

Uniform stress can only be secured by having a weight at the summit. The tower cannot come to a point.

II. Solution by S. A. COREY, Hiteman, Iowa.

Let x=vertical downward distance from the top of the tower. In order that all the parts of the structure may be subject to the same stress, the area of the circular cross section at any point must be proportional to the weight of the tower above. This condition will be approximately satisfied by assuming the area of the circular cross section to be e^{mx}, as then the volume of the part above will be $\int_0^x e^{mx}dx$, or e^{mx}/m, and the weight is directly proportional to the volume.

From $e^{mx}=\pi 20^2$ =area of base, when $x=1000$, follows $m=.007136$. If the weight of $1/m$ cubic feet (140 cubic feet) of the same material used in the tower be evenly distributed on the square foot of summit the given conditions are all approximately satisfied.

Also solved by G. B. M. Zerr, Parsons, W. Va.

MISCELLANEOUS.

143. Proposed by G. W. GREENWOOD, B. A. (Oxon), Professor of Mathematics and Astronomy, McKendree College, Lebanon, Ill.

If $A+B+C=180°$. show that $1-\cos^2A-\cos^2B-\cos^2C-2\cos A\cos B\cos C=0$.

Solution by MARY STEAGALL, Student at The University of Chicago.

Take $C=180°-(A+B)$. Then $\cos C=-\cos(A+B)$ and $\cos^2C=\cos^2(A+B)$. Introducing these values for $\cos C$ and $\cos^2C$ we have:

$$1-\cos^2A-\cos^2B-(\cos A\cos B-\sin A\sin B)^2+2\cos A\cos B(\cos A\cos B-\sin A\sin B)$$

Performing the operations indicated and putting $1-\cos^2A$ for $\sin^2A$, and $1-\cos^2B$ for $\sin^2B$ the terms reduce to 0.

Also solved by C. H. Brown, Richard Yates, G. E. Cadman and Adolph Pierrot, of Chicago, Ill.; Wm. Hoover, Ph. D., Athens, Ohio; E. L. Sherwood, Pittsburg, Pa.; S. A. Cory, Hiteman, Iowa; Nelson L. Roray, Palmyra, N. J.; M. E. Graber, Tiffin, Ohio; A. H. Holmes, Brunswick, Maine; G. B. M. Zerr, A. M., Ph. D., Parsons, W. Va.; F. D. Posey, A. B., San Mateo, Cal.; Christian Hornung, Tiffin, O.; J. Scheffer, Hagerstown, Md.; and the Proposer.